

Bibliography

- [Allen *et al.*, 1990] J. Allen, J. A. Hendler, and A. Tate, editors. *Readings in Planning*. Morgan Kaufmann Publishers, 1990.
- [Alur *et al.*, 1997] R. Alur, R. K. Brayton, T. A. Henzinger, S. Qadeer, and S. K. Rajamani. Partial-order reduction in symbolic state space exploration. In *Computer Aided Verification, 9th International Conference, CAV '97, Haifa, Israel, June 22-25, 1997, Proceedings*, volume 1254 of *Lecture Notes in Computer Science*, pages 340–351. Springer-Verlag, 1997.
- [Bacchus and Kabanza, 2000] F. Bacchus and F. Kabanza. Using temporal logics to express search control knowledge for planning. *Artificial Intelligence*, 116(1–2):123–191, 2000.
- [Bäckström and Nebel, 1995] C. Bäckström and B. Nebel. Complexity results for SAS⁺ planning. *Computational Intelligence*, 11(4):625–655, 1995.
- [Bahar *et al.*, 1997] R. I. Bahar, E. A. Frohm, C. M. Gaona, G. D. Hachtel, E. Macii, A. Pardo, and F. Somenzi. Algebraic decision diagrams and their applications. *Formal Methods in System Design: An International Journal*, 10(2/3):171–206, 1997.
- [Balcázar *et al.*, 1988] J. L. Balcázar, J. Díaz, and J. Gabarró. *Structural Complexity I*. Springer-Verlag, Berlin, 1988.
- [Balcázar *et al.*, 1990] J. L. Balcázar, J. Díaz, and J. Gabarró. *Structural Complexity II*. Springer-Verlag, Berlin, 1990.
- [Bertoli *et al.*, 2001] P. Bertoli, A. Cimatti, M. Roveri, and P. Traverso. Planning in nondeterministic domains under partial observability via symbolic model checking. In B. Nebel, editor, *Proceedings of the 17th International Joint Conference on Artificial Intelligence*, pages 473–478. Morgan Kaufmann Publishers, 2001.
- [Blum and Furst, 1997] A. L. Blum and M. L. Furst. Fast planning through planning graph analysis. *Artificial Intelligence*, 90(1-2):281–300, 1997.
- [Bonet and Geffner, 2000] B. Bonet and H. Geffner. Planning with incomplete information as heuristic search in belief space. In S. Chien, S. Kambhampati, and C. A. Knoblock, editors, *Proceedings of the Fifth International Conference on Artificial Intelligence Planning Systems*, pages 52–61. AAAI Press, 2000.
- [Bonet and Geffner, 2001] B. Bonet and H. Geffner. Planning as heuristic search. *Artificial Intelligence*, 129(1-2):5–33, 2001.

- [Brooks, 1991] R. A. Brooks. Intelligence without representation. *Artificial Intelligence*, 47:139–159, 1991.
- [Bryant, 1992] R. E. Bryant. Symbolic Boolean manipulation with ordered binary decision diagrams. *ACM Computing Surveys*, 24(3):293–318, September 1992.
- [Burch *et al.*, 1994] J. R. Burch, E. M. Clarke, D. E. Long, K. L. MacMillan, and D. L. Dill. Symbolic model checking for sequential circuit verification. *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, 13(4):401–424, 1994.
- [Bylander, 1994] T. Bylander. The computational complexity of propositional STRIPS planning. *Artificial Intelligence*, 69(1-2):165–204, 1994.
- [Chandra *et al.*, 1981] A. Chandra, D. Kozen, and L. Stockmeyer. Alternation. *Journal of the ACM*, 28(1):114–133, 1981.
- [Cimatti *et al.*, 2003] A. Cimatti, M. Pistore, M. Roveri, and P. Traverso. Weak, strong, and strong cyclic planning via symbolic model checking. *Artificial Intelligence*, 147(1–2):35–84, 2003.
- [Clarke *et al.*, 1994] E. Clarke, O. Grumberg, K. McMillan, and X. Zhao. Efficient generation of counterexamples and witnesses in symbolic model checking. Technical Report CS-94-204, Carnegie Mellon University, School of Computer Science, October 1994.
- [Darwiche, 2001] A. Darwiche. Decomposable negation normal form. *Journal of the ACM*, 48(4):1–42, 2001.
- [de Bakker and de Roever, 1972] J. W. de Bakker and W. P. de Roever. A calculus of recursive program schemes. In *Proceedings of the First International Colloquium on Automata, Languages and Programming*, pages 167–196. North-Holland, 1972.
- [Dijkstra, 1976] E. W. Dijkstra. *A Discipline of Programming*. Prentice Hall, Englewood Cliffs, New Jersey, 1976.
- [Emerson and Sistla, 1996] E. A. Emerson and A. P. Sistla. Symmetry and model-checking. *Formal Methods in System Design: An International Journal*, 9(1/2):105–131, 1996.
- [Ernst *et al.*, 1969] G. Ernst, A. Newell, and H. Simon. *GPS: A Case Study in Generality and Problem Solving*. Academic Press, 1969.
- [Erol *et al.*, 1995] K. Erol, D. S. Nau, and V. S. Subrahmanian. Complexity, decidability and undecidability results for domain-independent planning. *Artificial Intelligence*, 76(1–2):75–88, 1995.
- [Etzioni *et al.*, 1992] O. Etzioni, S. Hanks, D. Weld, D. Draper, N. Lesh, and M. Williamson. An approach to planning with incomplete information. In B. Nebel, C. Rich, and W. Swartout, editors, *Principles of Knowledge Representation and Reasoning: Proceedings of the Third International Conference (KR '92)*, pages 115–125. Morgan Kaufmann Publishers, October 1992.
- [Fikes and Nilsson, 1971] R. E. Fikes and N. J. Nilsson. STRIPS: a new approach to the application of theorem proving to problem solving. *Artificial Intelligence*, 2(2-3):189–208, 1971.

- [Fujita *et al.*, 1997] M. Fujita, P. C. McGeer, and J. C.-Y. Yang. Multi-terminal binary decision diagrams: an efficient data structure for matrix representation. *Formal Methods in System Design: An International Journal*, 10(2/3):149–169, 1997.
- [Ginsberg and Smith, 1988] M. L. Ginsberg and D. E. Smith. Reasoning about action I: A possible worlds approach. *Artificial Intelligence*, 35(2):165–195, 1988.
- [Ginsberg, 1989] M. L. Ginsberg. Universal planning: An (almost) universally bad idea. *AI Magazine*, 10(4):40–44, 1989.
- [Godefroid, 1991] P. Godefroid. Using partial orders to improve automatic verification methods. In E. M. Clarke, editor, *Proceedings of the 2nd International Conference on Computer-Aided Verification (CAV '90)*, Rutgers, New Jersey, 1990, number 531 in Lecture Notes in Computer Science, pages 176–185. Springer-Verlag, 1991.
- [Green, 1969] C. Green. Application of theorem-proving to problem solving. In D. E. Walker and L. M. Norton, editors, *Proceedings of the 1st International Joint Conference on Artificial Intelligence*, pages 219–239. William Kaufmann, 1969.
- [Hansen and Zilberstein, 2001] E. A. Hansen and S. Zilberstein. LAO *: A heuristic search algorithm that finds solutions with loops. *Artificial Intelligence*, 29(1-2):35–62, 2001.
- [Hart *et al.*, 1968] P. E. Hart, N. J. Nilsson, and B. Raphael. A formal basis for the heuristic determination of minimum-cost paths. *IEEE Transactions on System Sciences and Cybernetics*, SSC-4(2):100–107, 1968.
- [Haslum and Geffner, 2000] P. Haslum and H. Geffner. Admissible heuristics for optimal planning. In S. Chien, S. Kambhampati, and C. A. Knoblock, editors, *Proceedings of the Fifth International Conference on Artificial Intelligence Planning Systems*, pages 140–149. AAAI Press, 2000.
- [Haslum and Jonsson, 2000] P. Haslum and P. Jonsson. Some results on the complexity of planning with incomplete information. In S. Biundo and M. Fox, editors, *Recent Advances in AI Planning. Fifth European Conference on Planning (ECP'99)*, number 1809 in Lecture Notes in Artificial Intelligence, pages 308–318. Springer-Verlag, 2000.
- [Hoey *et al.*, 1999] J. Hoey, R. St-Aubin, A. Hu, and C. Boutilier. SPUDD: Stochastic planning using decision diagrams. In K. B. Laskey and H. Prade, editors, *Uncertainty in Artificial Intelligence, Proceedings of the Fifteenth Conference (UAI-99)*, pages 279–288. Morgan Kaufmann Publishers, 1999.
- [Hoffmann and Nebel, 2001] J. Hoffmann and B. Nebel. The FF planning system: Fast plan generation through heuristic search. *Journal of Artificial Intelligence Research*, 14:253–302, 2001.
- [Hopcroft and Ullman, 1979] J. E. Hopcroft and J. D. Ullman. *Introduction to Automata Theory, Languages, and Computation*. Addison-Wesley Publishing Company, 1979.
- [Ichikawa and Hiraishi, 1988] A. Ichikawa and K. Hiraishi. Analysis and control of discrete-event systems represented as Petri nets. In P. Varaiya and B. Kurzhanski, editors, *Discrete Event*

- Systems: Models and Applications, IIASA Conference, Sopron Hungary, August 3-7, 1987*, number 103 in Lecture Notes in Control and Information Sciences, pages 115–134. Springer-Verlag, 1988.
- [Kaelbling *et al.*, 1998] L. P. Kaelbling, M. L. Littman, and A. R. Cassandra. Planning and acting in partially observable stochastic domains. *Artificial Intelligence*, 101(1-2):99–134, 1998.
- [Kautz and Selman, 1992] H. Kautz and B. Selman. Planning as satisfiability. In B. Neumann, editor, *Proceedings of the 10th European Conference on Artificial Intelligence*, pages 359–363. John Wiley & Sons, 1992.
- [Kautz and Selman, 1996] H. Kautz and B. Selman. Pushing the envelope: planning, propositional logic, and stochastic search. In *Proceedings of the Thirteenth National Conference on Artificial Intelligence and the Eighth Innovative Applications of Artificial Intelligence Conference*, pages 1194–1201. AAAI Press, August 1996.
- [Kirkpatrick *et al.*, 1983] S. Kirkpatrick, C. D. Gelatt Jr., and M. P. Vecchi. Optimization by simulated annealing. *Science*, 220(4598):671–680, May 1983.
- [Knuth, 1998] D. E. Knuth. *Art of Computer Programming, Volume 3: Sorting and Searching*. Addison-Wesley Publishing Company, 1998.
- [Korf, 1985] R. E. Korf. Depth-first iterative deepening: an optimal admissible tree search. *Artificial Intelligence*, 27(1):97–109, 1985.
- [Kupferman and Vardi, 1999] O. Kupferman and M. Y. Vardi. Church’s problem revisited. *The Bulletin of Symbolic Logic*, pages 245–263, 1999.
- [Li and Wonham, 1993] Y. Li and W. M. Wonham. Control of vector discrete-event system I - the base model. *IEEE Transactions on Automatic Control*, 38(8):1214–1227, 1993.
- [Littman, 1997] M. L. Littman. Probabilistic propositional planning: Representations and complexity. In *Proceedings of the 14th National Conference on Artificial Intelligence (AAAI-97) and 9th Innovative Applications of Artificial Intelligence Conference (IAAI-97)*, pages 748–754, Menlo Park, July 1997. AAAI Press.
- [Lozano and Balcázar, 1990] A. Lozano and J. L. Balcázar. The complexity of graph problems for succinctly represented graphs. In M. Nagl, editor, *Graph-Theoretic Concepts in Computer Science, 15th International Workshop, WG’89*, number 411 in Lecture Notes in Computer Science, pages 277–286, Castle Rolduc, The Netherlands, 1990. Springer-Verlag.
- [Madani *et al.*, 2003] O. Madani, S. Hanks, and A. Condon. On the undecidability of probabilistic planning and related stochastic optimization problems. *Artificial Intelligence*, 147(1–2):5–34, 2003.
- [McAllester and Rosenblitt, 1991] D. A. McAllester and D. Rosenblitt. Systematic nonlinear planning. In T. L. Dean and K. McKeown, editors, *Proceedings of the 9th National Conference on Artificial Intelligence*, volume 2, pages 634–639. AAAI Press / The MIT Press, 1991.

- [Meyer and Stockmeyer, 1972] A. R. Meyer and L. J. Stockmeyer. The equivalence problem for regular expressions with squaring requires exponential time. In *Proceedings of the 13th Annual Symposium on Switching and Automata Theory*, pages 125–129, Long Beach, California, 1972. IEEE Computer Society.
- [Mundhenk *et al.*, 2000] M. Mundhenk, J. Goldsmith, C. Lusena, and E. Allender. Complexity of finite-horizon Markov decision process problems. *Journal of the ACM*, 47(4):681–720, 2000.
- [Muscettola *et al.*, 1998] N. Muscettola, P. P. Nayak, B. Pell, and B. C. Williams. Remote Agent: to boldly go where no AI system has gone before. *Artificial Intelligence*, 103(1-2):5–47, 1998.
- [Papadimitriou and Yannakakis, 1986] C. H. Papadimitriou and M. Yannakakis. A note on succinct representations of graphs. *Information and Control*, 71:181–185, 1986.
- [Papadimitriou, 1994] C. H. Papadimitriou. *Computational Complexity*. Addison-Wesley Publishing Company, 1994.
- [Pearl, 1984] J. Pearl. *Heuristics: Intelligent Search Strategies for Computer Problem Solving*. Addison-Wesley Publishing Company, Reading, Massachusetts, 1984.
- [Peot and Smith, 1992] M. A. Peot and D. E. Smith. Conditional nonlinear planning. In J. Hendler, editor, *Proceedings of the First International Conference on Artificial Intelligence Planning Systems*, pages 189–197, San Mateo, California, 1992. Morgan Kaufmann Publishers.
- [Pixley *et al.*, 1992] C. Pixley, S.-W. Jeong, and G. D. Hachtel. Exact calculation of synchronization sequences based on binary decision diagrams. In *Proceedings of the 29th Design Automation Conference*, pages 620–623, 1992.
- [Pryor and Collins, 1996] L. Pryor and G. Collins. Planning for contingencies: A decision-based approach. *Journal of Artificial Intelligence Research*, 4:287–339, 1996.
- [Puterman, 1994] M. L. Puterman. *Markov decision processes: discrete stochastic dynamic programming*. John Wiley & Sons, 1994.
- [Ramadge and Wonham, 1987] P. Ramadge and W. Wonham. Supervisory control of a class of discrete-event processes. *SIAM Journal of Control and Optimization*, 25(1):206–230, January 1987.
- [Rintanen *et al.*, 2004] J. Rintanen, K. Heljanko, and I. Niemelä. Parallel encodings of classical planning as satisfiability. In J. J. Alferes and J. Leite, editors, *Logics in Artificial Intelligence: 9th European Conference, JELIA 2004, Lisbon, Portugal, September 27-30, 2004. Proceedings*, number 3229 in Lecture Notes in Computer Science, pages 307–319. Springer-Verlag, 2004.
- [Rintanen, 1998] J. Rintanen. A planning algorithm not based on directional search. In A. G. Cohn, L. K. Schubert, and S. C. Shapiro, editors, *Principles of Knowledge Representation and Reasoning: Proceedings of the Sixth International Conference (KR '98)*, pages 617–624. Morgan Kaufmann Publishers, June 1998.
- [Rintanen, 2004] J. Rintanen. Distance estimates for planning in the discrete belief space. In *Proceedings of the Eighteenth National Conference on Artificial Intelligence (AAAI-2004) and the Thirteenth Conference on Innovative Applications of Artificial Intelligence (IAAI-2004)*, pages 525–530. AAAI Press, 2004.

- [Rosenschein, 1981] S. J. Rosenschein. Plan synthesis: A logical perspective. In P. J. Hayes, editor, *Proceedings of the 7th International Joint Conference on Artificial Intelligence*, pages 331–337, Los Altos, California, August 1981. William Kaufmann.
- [Sacerdoti, 1974] E. D. Sacerdoti. Planning in a hierarchy of abstraction spaces. *Artificial Intelligence*, 5:115–135, 1974.
- [Sacerdoti, 1975] E. D. Sacerdoti. The nonlinear nature of plans. In *Proceedings of the 4th International Joint Conference on Artificial Intelligence*, pages 206–214, 1975.
- [Sandewall, 1994a] E. Sandewall. *Features and Fluents. The Representation of Knowledge about Dynamic Systems.*, volume I. Oxford University Press, 1994.
- [Sandewall, 1994b] E. Sandewall. The range of applicability of nonmonotonic logics for the inertia problem. *Journal of Logic and Computation*, 4(5):581–615, 1994.
- [Schoppers, 1987] M. J. Schoppers. Universal plans for real-time robots in unpredictable environments. In *Proceedings of the 10th International Joint Conference on Artificial Intelligence*, pages 1039–1046, Milano, 1987.
- [Shoham, 1988] Y. Shoham. Chronological ignorance: Experiments in nonmonotonic temporal reasoning. *Artificial Intelligence*, 36(3):279–331, October 1988.
- [Smallwood and Sondik, 1973] R. D. Smallwood and E. J. Sondik. The optimal control of partially observable Markov processes over a finite horizon. *Operations Research*, 21:1071–1088, 1973.
- [Sondik, 1978] E. J. Sondik. The optimal control of partially observable Markov processes over the infinite horizon: discounted costs. *Operations Research*, 26(2):282–304, 1978.
- [Starke, 1991] P. H. Starke. Reachability analysis of Petri nets using symmetries. *Journal of Mathematical Modelling and Simulation in Systems Analysis*, 8(4/5):293–303, 1991.
- [Stein and Morgenstern, 1994] L. A. Stein and L. Morgenstern. Motivated action theory: a formal theory of causal reasoning. *Artificial Intelligence*, 71:1–42, 1994.
- [Stockmeyer and Chandra, 1979] L. J. Stockmeyer and A. K. Chandra. Provably difficult combinatorial games. *SIAM Journal on Computing*, 8(2):151–174, 1979.
- [Valmari, 1991] A. Valmari. Stubborn sets for reduced state space generation. In G. Rozenberg, editor, *Advances in Petri Nets 1990. 10th International Conference on Applications and Theory of Petri Nets, Bonn, Germany*, number 483 in Lecture Notes in Computer Science, pages 491–515. Springer-Verlag, 1991.
- [Vardi and Stockmeyer, 1985] M. Vardi and L. Stockmeyer. Improved upper and lower bounds for modal logics of programs. In *Proceedings of the 17th Annual ACM Symposium on Theory of Computing*, pages 240–251. Association for Computing Machinery, 1985.
- [Wonham, 1988] W. M. Wonham. A control theory for discrete-event systems. In M. Denham and A. Laub, editors, *Advanced Computing Concepts and Techniques in Control Engineering*, pages 129–169. Springer-Verlag, 1988.

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